THE EAST-WEST MIGRATION IN EUROPE: SKILL LEVELS OF MIGRANTS AND THEIR EFFECTS ON THE EUROPEAN LABOUR MARKET

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1 Introduction

Migration is one of the most controversial topics in the economic debate both at academic level (Zimmermann and Bauer, 2002) and at institutional level and represents one of the most relevant social phenomena in Europe (Zimmermann, 2004). On one hand, it constitutes a challenge for the welfare systems of the EU member states and a critical element for the European labour markets, which often are characterized by strong rigidities, especially in continental countries. On the other hand, it is seen as a possible remedy to the progressive ageing of population and is foreboded by many as a response to the chronic and unsatisfied excess demand of firms for high skilled workers, describing the predominant situation in the EU. Strong hopes are given from the fact that better educated individuals should be more inclined to migrate (Michael, 2006) since they have a higher ability to adapt to foreign cultures and to be well assimilated (Zimmerman, 2004). Moreover they have a wider range of employment opportunities (McKenna, 1996) and most importantly they could be attracted from the existence of a potential wage skill premium (Borjas, 1994 and 1999).

From the historical point of view, a further element was added to this picture: they are the negotiations which took place in the summits of Copenhagen (1993), Luxembourg (1997) and Helsinki (1999), that have prepared the way for the subsequent EU enlargement (may 2004) to ten New Member States (NMS) and to further two states in 2007. Except for Malta and Cyprus, all new member states[1] are Central and Eastern European Countries (CEECs), so that it has become usual to speak of Eastern European Enlargement. This is not at all a negligible aspect: since the '90s, in fact, there was the belief that the eastern enlargement would have triggered migration flows strongly larger than the previous enlargements[2] because of a wider income gap between "old" members and new members, as well as to a geographic proximity and cultural ties allowing for low "natural" migration barriers (Heijdra et alii, 2002). Conversely, the Eastern enlargement was indicated as appealing, being the eastern countries characterised by a high skilled labour force and by a large endowment of Human capital.

Recent history has confirmed most of these predictions: the EU has been flooded since the beginning of the transition process from great flows of East-West migration which have led many of the EU-15 countries (Boeri and Brucker, 2005) to introduce a few transitional restrictions on labour mobility of Eastern workers ranging from safeguard clauses to fixed quota systems. Initially only Denmark, Ireland, Sweden and the UK allowed eastern workers to move relatively freely across their national boundaries; Finland, Greece, Portugal and Spain removed all restrictions only in 2006, whereas the 6 remaining EU-15 countries are still now adopting some legislative barriers. In any case, regardless of the restrictions which have initially distorted migrants from CEECs' neighbouring countries towards those with more liberal migration policies, the flows

[1] Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic, Slovenia (2004), Bulgaria and Romania (2007)

[2] For example the so-called Southern enlargement

of people from CEECs towards the EU-15 member states have been constant throughout all the '90s (Boeri and Brucker, 2001) and since 2004 the effects of the enlargement have become even more visible and transversally wide-spread. According to the data reported in Barrell, FitzGerald and Riley (2007) between 2004 and the end of 2006, the percentage of residents coming from new member states should have increased of 265% in UK and of 63% in Ireland, but also less liberal countries like Germany (+83%) and Italy (+38.5%) have registered an absolutely relevant impact.

Therefore, it is not surprising that, since the cornerstone paper of Boeri and Brucker (2001) much literature has been dedicated to the study of the impact that the Eastern enlargement would have caused to a non perfect and strongly heterogeneous labour market as the European one, characterised by a high level of low skilled unemployment and in the meantime from a shortage of skilled workers.

Among the various issues faced by the debate, some have not yet received a clear cut answer: how has the skilled-unskilled wage gap responded in the host countries? And have the skilled-unskilled differentials of employment and participation widen or not?

The theoretical analysis on the reaction of the wage gap is inconclusive (see Bauer and Zimmermann, 1999; Rada, 2002 and Zimmermann, 2004 for surveys) and its indications are generally not very robust due to the fact that they depend on the hypothesis adopted regarding the degree of competitiveness of the host labour market, the skill mix of immigrants, the possibility of domestic and foreign labour of being substitutes or complements and the degree of replacement between skilled and unskilled labour.

Moreover, the empirical analysis (relative to both the EU-15 area and the USA) suffers some difficulties in gather informations on the characteristics of the migrants and in particular on their level of education and/or qualification [3] and it often consists in calibrations of general equilibrium models or RBC models, whose results risk being affected by the theoretical framework.

Nevertheless, in the sphere of the literature on labour markets some consensus over a few main indications[4] exists:

- The wage of unskilled workers tends to diminish (Lalonde and Topel, 1991 and 1992; Friedberg and Hunt, 1995; Borjas et alii, 1996; Borjas and Katz, 2005) and the skilled-unskilled gap tends to widen if migration is prevailingly unskilled (Bauer and Zimmermann, 1999; Rada, 2002; Heijdra et alii, 2002; Zimmermann, 2004) and permanent (Chang, 2001).
- In the case of skilled migration the response of the wage gap should be positive only in the long run and only if the growth of skilled labour supply triggers a phenomenon of skill biased technological change (Rada, 2002; Eggert, Krieger and Meier, 2007).

[3] For an education measurement method see Venturini and Villosio (2002)

[4] A "parallel" stream of research is given from the so called trade-approach (see Feenstra and Hanson, 2003 for a survey) according to which the trade in inputs acts as the skill bias technological progress, widening demand and relative wages of skilled workers, and therefore increasing wage differential.

- It is reasonable to deem that skilled and unskilled migrants are substitutes to similar native workers and that skilled and unskilled labour are complements.
- The unskilled labour market is usually characterised by a lower level of competitiveness and by wage bargaining mechanisms managed by Unions.

Any generalisation results in any case hazardous, considering the scarce robustness of the results with respect to different hypothesis of the underlying theoretical model, as well as to the methodologies used for the empirical exercise.

This paper tries to overcome the deadlock addressing one major and one minor issue among those characterising the macroeconomic literature on migration. Mainly we intend to evaluate, both on the theoretical and on the empirical side, which impact is produced by the immigration flows coming from the enlargement countries over the EU-15 labour market. As a second point we try to draw, from the empirical analysis, clues on the features of East-West migration from the point of view of the skill levels of immigrants.

Our study takes into account the fact that the European market is doubly segmented. On one side there is heterogeneity regarding the mechanism of access to the labour market and of wage determination: employed workers- the insiders- which are usually unionised, benefit from a higher average wage than that of equilibrium which characterises a perfectly competitive market, whereas outsiders are discriminated from the action of a monopolistic Union. Parallel to this, a segmentation exists among workers defined as skilled on the basis of their high level of education and/or professional qualification and unskilled workers.

There are two major innovations in this work:

1. Following an eclectic approach we adopt a insider/outsider type model inspired by that of Amisano and Serati (2003) but further on enlarged and corrected in order to:
   - Incorporate an equation that endogenously models the migration flows
   - Allow for modelling the trends of wage, participation and employment differentials between skilled and unskilled workers.

The use of an insider/outsider (henceforth I/O) model to study the impact of migration over a segmented market already appears in Bauer and Zimmermann (1999); differently from them, however, we handle the (relative) labour force as a fully endogenous variable, depending not only on migration flows but also on general labour market conditions and might also describe a kind of "encouraged work" phenomenon. Moreover, we explicit the insider/outsider mechanism assuming that the bargained wage is a negative function of the expected level of unemployment. Also Pischke and Velling (1994) for Germany and Dolado, Jimeno and Duce (1996) for Spain take into account the existence of some wage rigidity, but the first ones are not able to separate between low qualified and high qualified labour, whereas the hypothesis by Dolado, Jimeno and Duce (1996) of complementarity between immigrants and natives and of possible substitution between skilled and unskilled labour now do not appear very reasonable.

2. Second, after having estimated through Bayesian techniques the reduced VAR form of the theoretical model, we identify the structural shocks through sign restrictions (Faust, 1998; Uhlig, 1999; Canova e De Nicolò, 2002) imposed to the Impulse Response Functions (henceforth IRFs) and suggested from the theoretical model's impact multipliers. Within this framework we also try to obtain a set of information on the skill mix of the Eastern migrants leaving unconstrained only the impact multipliers of relative (skilled to unskilled) wage, employment and labour force with respect to a migration shock.

This is equivalent to adopt an agnostic approach (à la Uhlig, 1999), letting emerge freely the signals coming from the data and combining them with theoretical suggestions in order to derive at least weak indications on the fact that the skill mix of migrants is either biased towards high or low qualified labour.The remainder of the paper is organised as follows. Section 2 provides a brief sketch on migration flows towards Europe; in section 3 we present our I/O theoretical model for the analysis of real wage, employment, participation and migration skilled-unskilled differentials. Section 4 is dedicated to estimation issues whereas empirical results and comments are presented in section 5. Section 6 concludes.

2 Migration towards Europe: a very brief sketch

International migration in Europe was strongly influenced from institutional barriers. On one side, barriers to international migration have been removed across Western Europe up to the creation of a Single Market, whereas on the other, following the recession of 1973, they have established for the immigration from Eastern and Southern European countries. Although the end of socialism led to the removal of barriers towards a region of about 400 million people, the restrictions present in Western Europe have effectively avoided a large scale immigration from East to West.

In relative terms, the size of the European migration is smaller than that of North America, Australia and New Zealand. However, in absolute terms, Western Europe is the main migration target zone after North America: it has received about 15 million immigrants since World War II and its amount of foreign population is about 20 million immigrants in 2000.

During the last years a significant increase of immigrants has been registered in the countries belonging to the EU-25, so that net migration[5] shifted from 590 000 people in 1994 to 1.85 million in 2004 (Eurostat, 2006, 2007)[6].

International migration in Europe is quite a regional phenomenon: most of the foreign population present in Western European countries come from Southern and Eastern Europe and from neighbouring North African and Eastern European regions.

[5] Difference between immigration into the area and migration out of the area during the year

[6] These data could underevaluate the real amount of migration flows among countries due to the fact that not-legal migration is not included.

The composition of the European migration flows in terms of countries of origin has changed in the last three decades. In the '60s and '70s, most foreign population and Western European labour force was made up from individuals coming from Southern European countries, that today are EU members. Afterwards, the main sources of migration became non EU-15 countries from south-east Europe and North Africa. In particular we observe that the main countries of origin of the immigration flows are Latvia, Lithuania, Poland and Slovakia (Fihel *et alii*, 2006). This change in the geography of the countries of origin is associated to an increase in the wage differential and to differences in human capital endowments between destination countries and countries of origin.

Even the pattern of destination countries has registered a change which is due to some extent to immigration policies and also to socio-economic factors. Most of the EU-15 member states have imposed some restrictions on immigration from Central and Eastern European countries following the EU enlargement occurred in may 2004 and what emerges (Boeri and Brücker, 2005) is that such restrictions have generated a shift of migrants from traditional destinations, as neighbouring countries (Austria, Germany, Italy) towards countries adopting more liberal immigration policies (Denmark, Ireland, Sweden and UK).

From the starting date of the enlargement to the third quarter of 2006 the main changes in the amount of foreign citizens from NMS have been registered in Denmark, Ireland, Sweden and UK. Moreover, it was highlighted a minor impact of the enlargement on migration towards Scandinavian countries compared to UK and Ireland [7]. Anyway the main destination of immigration flows seems to be the United Kingdom: the flows of annual net migration have shifted from about 50 thousand to 150 thousand per year (Barrell *et alii*, 2007), although in terms of population size the impact seems to be lower than in the Irish case.

As for Austria, Germany and Italy, which were expected to receive the majority of immigrants after the enlargement, it emerges on the contrary a weaker growth of immigration flows from NMS. The data of the Austrian Federal Ministry for Economic Affairs and Labour, reported in Biffl (2007), reveal that migrants from NMS employed in Austria are above average for most of 2005. In Italy, between January 2003 and January 2006 the number of foreigners from NMS has increased from 42.2 to 80.7 thousand (complying to the statistics of population supplied by ISTAT). Moreover, we observe that the total foreign population in Italy has increased from 1.3 millions to 2.4 millions from January 2003 to January 2006 with a strong increase of the number of migrants from Albania and Romania.

Germany has traditionally been a main destination for Polish emigrants. The number of Polish resident in Germany has been on average of 318 thousands in the years from 2001 to 2003. In 2004 the number of Polish in Germany has reduced of 35 thousands so that it is hypothesized (Fihel *et alii*, 2006) that Polish emigrants after the enlargement have substituted traditional destination

[7] In particular, in Ireland the number of citizens of NMS has shifted from 1.5% of the total working age population to 2.2%.

countries with other destinations. The data of the Federal Statistical Office suggest that foreign population has decreased from 7.342 thousand at the end of 2003 to 7.288 thousand at the end of 2004, remaining virtually unvaried in 2005.

3 A structural Insider/Outsider model allowing for migration

3.1 The theoretical model: short and long-run properties

The model described in this section follows the Insider/Outsider tradition (Layard, Nickell and Jackman, 1991; Balmaseda, Dolado, Lopez-Salido, 2000) and it is a modified version of the one contained in Amisano and Serati[8] (2003). The main extension is that we add a specific equation that models migration in accordance with the approach proposed by Harris and Todaro (1970). In their model, Harris and Todaro (1970) analyze migration from rural towards urban areas in developing economies but this approach more generally can also be applied to cross-countries migration especially when the migrant flows go from poorer to richer countries.

The model referred to the aggregate[9] labour market is:

$$
\begin{aligned}
AD &: \quad y_t = \phi(d_t - p_t) + a\theta_t && (1)\\
AS &: \quad y_t = n_t + \theta_t && (2)\\
PS &: \quad p_t = w_t - \theta_t && (3)\\
WS &: \quad w_t = \{w_t : n_t^e = \overline{n}_t - \rho mg_t - \theta_t\} && (4)\\
\overline{n}_t &= \quad \lambda l_{t-1} + (1-\lambda) n_{t-1} && (5)\\
PE &: \quad l_t = \alpha(w_t - p_t^e) - bu_{t-1} + \gamma mg_t + z_t && (6)\\
IMM &: \quad mg_t = -\kappa u_t + \beta(w_t - p_t^c) + \xi_t && (7)\\
d_t, &\sim \quad w.n.(0,\sigma^d);\ \theta_t \sim w.n.(0,\sigma^\theta); d_t, \sim w.n.(0,\sigma^z); d_t, \sim w.n.(0,\sigma^\xi) && (8)
\end{aligned}
$$

Equation (1), (2) and (3) are exactly as in the AS03 paper: on the aggregate demand (AD) side, output depends on real aggregate demand ($d_t - p_t$) and on a productivity shock (θ_t). Aggregate supply (AS) depends only on labour (n_t) and on a productivity shock. Price setting is according to a fixed mark-up mechanism (price setting, or PS equation). The wage setting equation (WS) states that the nominal wage (w_t) is set in advance in order to achieve an expected level of employment which is a convex combination ($0 < \lambda < 1; \lambda =$ weight of the outsiders in wage setting) of the previous level of employment and the previous level of participation, with two push factors, one linked to the productivity

[8] Henceforth AS03

[9] Without splitting skilled and unskilled components.

level, and another (mg_t) that in our view results from the presence of a share of migrants entering the labour market. Our assumption that migration could be identified as a wage push factor is supported by the majority of empirical works that, despite theoretical fears on negative immigration effects, find a positive elasticity of domestic European wages with respect to an increase of foreign employment (DeNew and Zimmermann, 1994; Bauer, 1997; Hatzius, 1994; Pischke and Velling, 1994; Brucker, 2002 and Zimmermann, 2004 for surveys)[10]. Anyway, as it will be evident in the next section, in the empirical estimation we will adopt an agnostic approach with respect to this assumption, enablinf information coming from the data to give us a final and definite response.

The participation equation (PE) (??) links participation (l_t) to expected real wage, to past unemployment (discouragement effect), to migration ($0 < \gamma < 1$) and to a stochastic disturbance z_t .

In accordance to Harris and Todaro (1970), expression (7) states that migration is boosted from a low host unemployment (higher probability to find a job) and a high expected real wage (potential income gain).

We call the innovations d_t, θ_t, z_t and ξ_t *aggregate demand, aggregate supply (or productivity), participation and migration* shocks, respectively, with a clear reference to standard macroeconomic analysis. Moreover we assume for simplicity that all the stochastic terms are generated from stationary DGPs.

By combining equations (1) to (4), we can obtain the following employment equation:

$$n_t = \phi d_t - \phi w_t + (\phi + a - 1)\theta_t \tag{9}$$

and the following wage equation[11]:

$$w_t = -\frac{1}{\phi}(\lambda l_{t-1} + (1-\lambda)n_{t-1}) + \frac{\rho}{\phi} mg_t + \theta_t \tag{10}$$

By combining equations (1), (2) and (3) we have:

$$p_t = \frac{\phi}{a+\phi-1} d_t + \frac{a-1}{a+\phi-1} w_t - \frac{1}{a+\phi-1} n_t$$

Taking expectations of p_t and and substituting p^e into Participation Equation (6) we obtain:

$$l_t = -b(l_{t-1} - n_{t-1}) + \gamma mg_t + z_t, \text{where } 0 < \gamma < 1 \tag{11}$$

In the same way the Migration equation (7) becomes:

$$mg_t = -\kappa u_t + \xi_t \tag{12}$$

[10] We do not forget that there exist also some empirical papers that reach the opposite conclusion especially for Germany and Austria (Winter-Ebmer and Zimmermann, 2000; Brucker *et alii* 2001 are two examples): negative impact of migration on wages.

[11] Notice that wage is set in advance so that $w_t^e = w_t$. Moreover $d_t^e = d_{t-1}$ and $\theta_t^e = \theta_{t-1}$

Let us take into account the fact that the European labour market is splitted in two parts a skilled and an unskilled one, which we suppose to be symmetric and independent among them and let us suppose for simplicity that they are characterized by the same deep behavioral structural parameters. Labeling variables referring to skilled and unskilled workers respectively with apex s and us, it results immediate to obtain a version of our model expressed in terms of relative "skilled to unskilled" variables:

$$\begin{aligned}
&(n_t^s - n_t^{us}) = \phi\widetilde{d}_t - \phi(w_t^s - w_t^{us}) + (\phi + a - 1)\widetilde{\theta}_t \\
&(w_t^s - w_t^{us}) = -\tfrac{1}{\phi}[\lambda(l_{t-1}^s - l_{t-1}^{us}) + (1-\lambda)(n_{t-1}^s - n_{t-1}^{us})] + \tfrac{\rho}{\phi}(mg_t^s - mg_t^{us}) + \widetilde{\theta}_t \\
&(l_t^s - l_t^{us}) = -b(l_{t-1}^s - l_{t-1}^{us} - n_{t-1}^s + n_{t-1}^{us}) + \gamma(mg_t^s - mg_t^{us}) + \widetilde{z}_t \\
&(mg_t^s - mg_t^{us}) = -\kappa(l_t^s - l_t^{us} - n_t^s + n_t^{us}) + \widetilde{\xi}_t
\end{aligned} \tag{13}$$

Notice that also the shock terms should be understood as relative shocks: in particular $\widetilde{d}_t$ and $\widetilde{\theta}_t$ indicate respectively demand and productivity shocks that affect the skilled labour intensive sectors with respect to the unskilled intensive ones.

All variables are expressed in logarithms.

Let us collect the endogenous variable in the (4×1) vector:

$X_t = \left[n_t^s - n_t^{us} \quad w_t^s - w_t^{us} \quad l_t^s - l_t^{us} \quad mg_t^s - mg_t^{us}\right]'$;

the matrix representation of the structural system (13) is:

$$A_0 X_t + A_1 X_{t-1} = \Theta\Xi; \tag{14}$$

$\Xi = \left[\widetilde{d}_t \quad \widetilde{\theta}_t \quad \widetilde{z}_t \quad \widetilde{\xi}_t\right]'$

with:

$$A_0 = \begin{bmatrix} 1 & \phi & 0 & 0 \\ 0 & 1 & 0 & -\frac{\rho}{\phi} \\ 0 & 0 & 1 & -\gamma \\ -\kappa & 0 & \kappa & 1 \end{bmatrix}, \; A_1 = \begin{bmatrix} 0 & 0 & 0 & 0 \\ \frac{1-\lambda}{\phi} & 0 & \frac{\lambda}{\phi} & 0 \\ -b & 0 & b & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix},$$

$$\Theta = \begin{bmatrix} \phi & \phi + a - 1 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Starting from (14), the static long run equilibrium solution of the model is obtained by setting (for algebra see the Appendix): $X_t = X_{t-1} = X^*$ so that $X^* = (A_0 + A_1)^{-1}\Theta\Xi = Q\Xi$

$$Q = \begin{bmatrix} \frac{\phi(b+\kappa\gamma+1)}{\lambda+\rho\kappa} & \frac{(b+\kappa\gamma+1)(a-1)}{\lambda+\rho\kappa} & 1 & \frac{(-\rho-b\rho+\lambda\gamma)}{\lambda+\rho\kappa} \\ \frac{\phi(-b+\lambda+\rho\kappa-\kappa\gamma-1)}{\lambda\phi+\rho\kappa\phi} & -\frac{(a-b+\lambda+ab-a\lambda+\rho\kappa-\kappa\gamma-\lambda\phi-a\rho\kappa+a\kappa\gamma-\rho\kappa\phi-1)}{\phi(\lambda+\rho\kappa)} & -\frac{1}{\phi} & \frac{(\rho+b\rho-\lambda\gamma)}{\lambda\phi+\rho\kappa\phi} \\ \phi\frac{b+\kappa\gamma}{\lambda+\rho\kappa} & \frac{(b+\kappa\gamma)(a-1)}{\lambda+\rho\kappa} & 1 & \frac{(-b\rho+\lambda\gamma)}{\lambda+\rho\kappa} \\ \kappa\frac{\phi}{\lambda+\rho\kappa} & \frac{(a-1)\kappa}{\lambda+\rho\kappa} & 0 & \frac{\lambda}{\lambda+\rho\kappa} \end{bmatrix}$$

3.2 Impact coefficients: how to inspire a set of theory-instigated sign restrictions

It is of particular interest to examine the impact multipliers collected in matrix $A_0^{-1}\Theta$; they show the instantaneous responses of the endogenous variables with respect to the structural shocks of the model. Their sign may be used to build sign restrictions on which basis it is possible to identify both in the formal and in the economic sense the shocks of a (Structural) VAR representing the reduced form of the theoretical model. Once that identification has been obtained, simulating the dynamic behavior of our system is straightforward.

Let us look at matrix:

$$A_0^{-1}\Theta = \begin{bmatrix} \frac{\phi(\kappa\gamma+1)}{\rho\kappa+\kappa\gamma+1} & \frac{(a-1)(\kappa\gamma+1)}{\rho\kappa+\kappa\gamma+1} & \rho\frac{\kappa}{\rho\kappa+\kappa\gamma+1} & -\frac{\rho}{\rho\kappa+\kappa\gamma+1} \\ \frac{\rho\kappa\phi}{\phi+\rho\kappa\phi+\kappa\gamma\phi} & \frac{(\phi-\rho\kappa+a\rho\kappa+\rho\kappa\phi+\kappa\gamma\phi)}{\phi(1+\rho\kappa+\kappa\gamma)} & -\rho\frac{\kappa}{\phi+\rho\kappa\phi+\kappa\gamma\phi} & \frac{\rho}{\phi+\rho\kappa\phi+\kappa\gamma\phi} \\ \frac{\kappa\gamma\phi}{\rho\kappa+\kappa\gamma+1} & \frac{(a-1)\kappa\gamma}{\rho\kappa+\kappa\gamma+1} & \frac{\rho\kappa+1}{\rho\kappa+\kappa\gamma+1} & \frac{\gamma}{\rho\kappa+\kappa\gamma+1} \\ \frac{\kappa\phi}{\rho\kappa+\kappa\gamma+1} & \frac{(a-1)\kappa}{\rho\kappa+\kappa\gamma+1} & -\frac{\kappa}{\rho\kappa+\kappa\gamma+1} & \frac{1}{\rho\kappa+\kappa\gamma+1} \end{bmatrix}$$

We observe that:

- $\frac{\partial(n_t^s-n_t^{us})}{\partial\tilde{d}_t} = \phi\frac{\kappa\gamma+1}{\rho\kappa+\kappa\gamma+1} > 0; \frac{\partial(w_t^s-w_t^{us})}{\partial\tilde{d}_t} = \frac{\rho\kappa\phi}{\phi+\rho\kappa\phi+\kappa\gamma\phi} > 0; \frac{\partial(l_t^s-l_t^{us})}{\partial\tilde{d}_t} = \frac{\kappa\gamma\phi}{\rho\kappa+\kappa\gamma+1} > 0; \frac{\partial(mg_t^s-mg_t^{us})}{\partial\tilde{d}_t} = \frac{\kappa\phi}{\rho\kappa+\kappa\gamma+1} > 0$

A (relative skilled to unskilled) aggregate demand shock produces a positive impact effect on all the (relative) variables: employment raises to match the growing labour demand expressed by firms that intend to increase their production levels. An encouraged labour mechanism triggers a growth of participation which size is smaller than the employment effect so that unemployment decreases. This fact has a positive impact effect on wages[12] and incentives new migration flows.

- $\frac{\partial(n_t^s-n_t^{us})}{\partial\tilde{\theta}_t} = \frac{(a-1)(\kappa\gamma+1)}{\rho\kappa+\kappa\gamma+1} < 0; \frac{\partial(w_t^s-w_t^{us})}{\partial\tilde{\theta}_t} = \frac{(\phi-\rho\kappa+a\rho\kappa+\rho\kappa\phi+\kappa\gamma\phi)}{\phi(1+\rho\kappa+\kappa\gamma)} > 0;$

$\frac{\partial(l_t^s-l_t^{us})}{\partial\tilde{\theta}_t} = \frac{(a-1)\kappa\gamma}{\rho\kappa+\kappa\gamma+1} < 0; \frac{\partial(mg_t^s-mg_t^{us})}{\partial\tilde{\theta}_t} = \frac{(a-1)\kappa}{\rho\kappa+\kappa\gamma+1} < 0$

As it is customary in many labour market models allowing for real rigidities the theoretical sign of the short run effects of a productivity shock is a-priori uncertain save for the wages that show a growth tendency; in particular, the sign of impact multipliers in our model depends from that of the term $(a-1)$. Despite that, (a) taking into account that the positive structural growth effects of productivity should appear on in the long run, whereas in the short run it is expected a substitution of labour with capital also in skilled labour intensive sectors, and (b) following the empirical literature (Amisano and Serati, 2003) that finds for parameter a negative estimated values, we assume that $(a-1) < 0$.This implies a negative instantaneous response of l_t, n_t and mg_t differentials.

[12] It is worth to remember that in the very short run (impact effect) the insider/outsider mechanism is not **attivo, poichè the Unions manage the wages on the basis of the past and not the current behaviour of n_t and l_t** (notice that the parameter λ that measures the strenght of the I/O mechanism does not influence the impact multipliers).

- $\frac{\partial(n_t^s - n_t^{us})}{\partial \tilde{z}_t} = \frac{\rho\kappa}{\rho\kappa+\kappa\gamma+1} > 0; \frac{\partial(w_t^s - w_t^{us})}{\partial \tilde{z}_t} = -\frac{\rho\kappa}{\phi+\rho\kappa\phi+\kappa\gamma\phi} < 0; \frac{\partial(l_t^s - l_t^{us})}{\partial \tilde{z}_t} = \frac{\rho\kappa+1}{\rho\kappa+\kappa\gamma+1} > 0; \frac{\partial(mg_t^s - mg_t^{us})}{\partial \tilde{z}_t} = -\frac{\kappa}{\rho\kappa+\kappa\gamma+1} < 0$

(Relative) Employment reacts positively to a (relative) participation shock, whereas the wage should reduce ($\frac{\partial(n_t^s - n_t^{us})}{\partial \tilde{z}_t} < \frac{\partial(l_t^s - l_t^{us})}{\partial \tilde{z}_t}$). The shrinkage of the wage premium discourages the potential flows of skilled migrants ($\frac{\partial(mg_t^s - mg_t^{us})}{\partial \tilde{z}_t} < 0$).

- $\frac{\partial(n_t^s - n_t^{us})}{\partial \tilde{\xi}_t} = -\frac{\rho}{\rho\kappa+\kappa\gamma+1} < 0; \frac{\partial(w_t^s - w_t^{us})}{\partial \tilde{\xi}_t} = \frac{\rho}{\phi+\rho\kappa\phi+\kappa\gamma\phi} > 0; \frac{\partial(l_t^s - l_t^{us})}{\partial \tilde{\xi}_t} = \frac{\gamma}{\rho\kappa+\kappa\gamma+1} > 0; \frac{\partial(mg_t^s - mg_t^{us})}{\partial \tilde{\xi}_t} = \frac{1}{\rho\kappa+\kappa\gamma+1} > 0$

Skilled to unskilled relative wage is positively influenced (at time 0) by a growth of skilled migration that also boosts (relative) skilled participation. On the contrary, employment seems to suffer a kind of crowding out effect due to wage growth. It is necessary to notice that all impact effects could result reverse in the case of an increase of unskilled migration with respect to a skilled one.

4 The empirically estimated model

4.1 Specification issues

We estimate a unrestricted VAR model with deterministic variables that can be thought as the reduced form of our structural model described in equation 14:

$\Phi(L)X_t = \Psi d_t + \epsilon_t, \epsilon_t \sim VWN(0, H^{-1})$,

$X_t = \left[n_t^s - n_t^{us} \quad w_t^s - w_t^{us} \quad l_t^s - l_t^{us} \quad mg_t^s - mg_t^{us}\right]'$

We are interested in conducting inference on the dynamic responses of the endogenous variables with respect to the structural shocks identified within the theoretical model, with a particular attention on the quality shock. For this purpose we need to structure the VAR system and identify a set of orthogonal shocks that admit a structural economic interpretation. Different identification strategies, usually based on zero restrictions on the impulse responses, have been proposed in the structural VAR literature: Christiano, Eichenbaum and Evans (2005) adopt a recursive identification scheme based on restrictions on the impact multipliers whereas Blanchard and Quah (1989) and Clarida and Galì (1994) impose long run restrictions. Exclusion restrictions are often criticized in the literature: Faust and Leeper (1997) show that small sample bias and measurement errors may induce substantial distortions in the estimations when using long run zero restrictions. On the other side, short run restrictions may be to much stringent and misleading: in many cases they are introduced not due to theoretical reasonings but they are imposed from the necessity to respect order and rank conditions for identification; moreover Peersman (2004) shows that a number of impulse responses based on zero restrictions are located in the tails of the distributions of all possible impulse responses.

In order to avoid technical problems of this sort in this paper we follow an identification strategy based on sign restrictions (Faust, 1998; Uhlig, 1999; Canova and De Nicolò, 2002): different shocks are identified according to the direction of their impact on the variables in the system as it is suggested by the multipliers contained in matrix A_0^{-1}. Canova and Paustian (2007) show the many advantages of this strategy compared to an alternative one based on classical or Bayesian structural estimation especially when the theoretical framework of reference is a business cycle based model. Firstly it is not necessary to assume that the model is the true DGP of the data, like in classical estimation; on the other side we can avoid the large computational costs and the difficulties of interpretation of misspecified estimates not infrequent in the structural Bayesian approach. Anyway, in order to unambiguous deliver the correct sign of the impulse responses a sufficiently large number of restrictions must be imposed. In our case this condition is largely met: in fact the theoretical model returns the precise sign of all the impact multipliers, so that it is possible to disentangle all the shocks on the basis of sign restrictions.

We do not have in hand sufficiently long and reliable series of data on the characteristics of migrants regarding their educational level or their professional qualification; in other words we are not able to distinguish skilled and unskilled migration on the basis of some statistical evidence. As a consequence we have to use aggregate data on migration flows so that: $X_t = \begin{bmatrix} n_t^s - n_t^{us} & w_t^s - w_t^{us} & l_t^s - l_t^{us} & mg_t \end{bmatrix}'$

Anyway, based on the suggestions coming from our theoretical model, we know that if the skill mix characterizing the migration flows is biased towards the skilled component, then (relative) wage and participation should exhibit a positive impact response whereas employment a negative one, and vice versa if the skill mix leans in favour of unskilled migrants. In other words it is possible to use the sign of the estimated impact multipliers to draw indications on the type of migration occurring. In light of this, our identification strategy imposes sign restrictions to all the impact multipliers with the exception of those describing the system responses to migration shocks. From their unconstrained estimation, compared with the suggestions of the theoretical model, we will be able to understand which skill intensity characterizes the migration flows from the enlargement countries to the EU-15 zone and which short and long term consequences are generated over the destination labour markets.

As for the estimation technique we opt for a Bayesian approach. At first we follow the Sims and Zha (2005a) methodology to obtain the posterior of the model parameters in an exactly identified SVAR (a recursive system). Then we use a MCMC multi step procedure Rubio-Ramirez *et alii*, 2005). At first step we draw from the SVAR posterior distribution; then at the second step we draw an independent standard normal (4×4) matrix Z and decompose it so that $Z = WR$, with diagonal elements of R being positive. In the last step we use W as rotation matrix in order to generate a new set of impulse responses. If they do not satisfy the sign restrictions we repeat the second step, otherwise we store them and return to step 1. Given all the stored draws one can compute the first and second moments of the dynamic multipliers and also their $s\%$ percentiles

and use them to provide the whole shape of the impulse response functions and their confidence bounds.

We run 1000 replications of the three steps algorithm and report the median responses, together with their 84th and 16th percentiles error bands; the time period over which sign restrictions are set to be binding is one quarter, i.e. we are constraining only the impact multipliers.

4.2 Data definition and sources

In this sub-section we describe the variables used in the empirical work, their statistical properties and the basic specification of the VAR model.

Data on employment and participation are relative to the whole EU-15 area considered as a single country. The source of data is Eurostat which original series of active population and employment are classified into three groups according to three different levels of education[13]. We use data of the first group as representative of unskilled workers and the aggregation of data in groups 2 and 3 in order to obtain employment and participation measures for skilled workers.

Immigration data are obtained by aggregation of migrants flows by sex, citizenship and previous country of residence from any single enlargement country to each one of the EU-15 members. Source is Eurostat.

Skilled and unskilled wages have been reconstructed through a multi-step procedure starting from a dataset, provided by NBER, in which wages[14] are monitored by sector, country and type of job. First step was that of re-classifying jobs dividing them in two categories: skilled jobs that require a higher level of education (at least a high school diploma) and unskilled ones for which it is enough a primary education diploma. For both categories, single country wages have been computed as averages with respect to sectors and jobs. Finally, the average wages for EU-15 (both skilled and unskilled) have been generated as the weighted average of wages of single members, with the weights given from the ratio between the country specific amount of employed over the total EU-15 employment.

For all data the sample period goes from the first quarter of 1992 to the last quarter of 2006

Figures 1 and 2 plot respectively the original series and the skilled to unskilled differentials.

It is easily observable how all indicators relative to the skilled labour market appear on the rise, whereas the opposite occurs for the unskilled market. Only wages represent a partial exception, in the sense that they both present a growing trend from the mid '80s up to 2002 and only at that moment onward they

[13]Group 1: ISCED 0-2 pre-primary, primary and lower secondary education.
Group 2: ISCED 3-4 upper secondary and post-secondary non-tertiary education
Group 3: ISCED 5-6 tertiary education
[14]Expressed in Euros

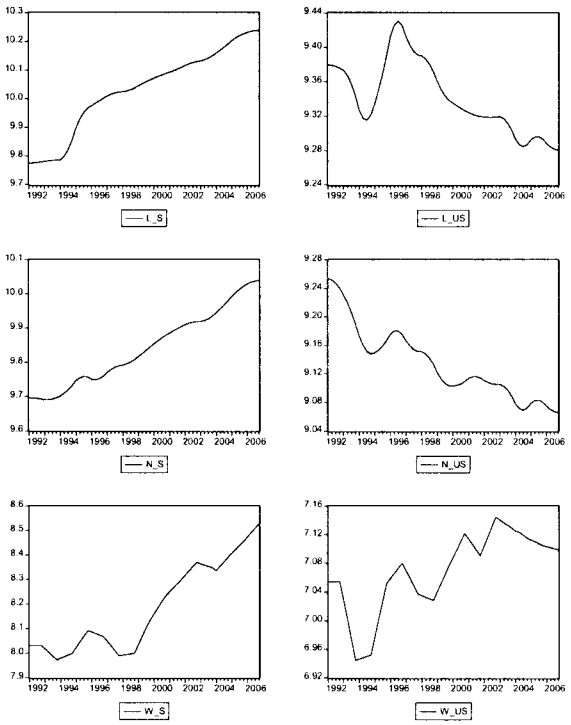

Figure 1:

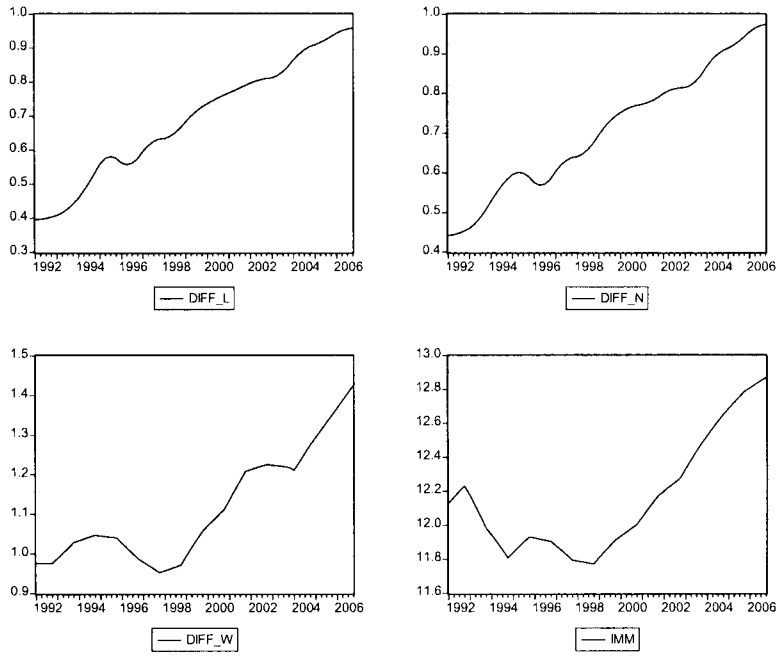

Figure 2:

are characterised by an opposite evolution. Skilled wages tend to grow while unskilled ones show a slight downturn.

The net result of these dynamics is shown in figure 2, which shows clearly the progressive widening of gaps among skilled and unskilled variables since 1996, that is accompanied by a nearly continuous increase of migration flows inwards. In particular, the evolution of $(l_t^s - l_t^{us})$ enables the supposition that a relevant share of migrants is characterised by high levels of skills and education.

A preliminary exam of the statistical properties of the series has revealed that all four result in being characterized by the presence of a Unit Root; the result appears to be robust with respect to the specific unit root test we run (results are available upon request)[15].

Keeping into consideration the evidence emerged during the preliminary analysis we have fit the VAR to first differences[16] of the four endogenous variables and we have imposed sign restrictions to cumulated IRFs. The adopted final specification allows for four lags of the endogenous variables and does not include any deterministic dummy variable[17]

5 Estimation results and comments

While commenting on the empirical findings it is necessary to remind again that all variables and shocks should be intended as relative ones (skilled to unskilled). Figure 3 reports the panel of simulated Impulse Response Functions (IRFs) together with their confidence bounds.

It is important to stress that our empirical strategy is not intended to provide the estimation of the structural model, but of its reduced form: the role reserved to the indications coming from the theory is limited to the definition of the sign restrictions on the basis of which is identified the structural Bayesian VAR. Such a way a relevant weight in the estimation is attributed to the information contained in the data on which they lie upon only "light" constraints so that a-priori it would not be possible to exclude that some findings could be in contrast with the theoretical predictions (more than what is considered to be "physiological" for any empirical exercise). However, in this case the results of our estimation do not seem to be affected by this specific type of drawback and they appear theory-consistent both in the short and also in the long run.

Let us start with the comments over the IRFs relative to the migration shock (fourth row of graphs in the panel) that represent the main focus of this work

[15] We also performed a Johansen cointegration trace test and we found evidence in favour of the existence of two cointegrating vectors one describing a relationship between employment and labour force differentials, the other one identified ad a stationary combination of labour force differential and migration flows

[16] In a Vector Error Correction form

[17] The statistical significance of various dummy variables, created in order to control for a set of *una tantum* political events (German Unification, withdrawal of the Lira from the European Monetary system, start up of European Monetary Union and others..), has been surveyed. None of them results being significant.

and are the only ones that we did not constrain just to avoid a bias "a-priori" on their behaviour and in the meantime to obtain indications on the characteristics of migrants from Eastern Europe. A preliminary visual inspection reveals that they describe an overall picture which is coherent with what was suggested from our theoretical model. First of all, one may observe that a migration shock causes a positive response of labour force differential both in the short and long run, which is one of the most significant elements supporting the hypothesis that East-West migration involves mainly workers with high level of skills that, rapidly, undertake a job search activity. Second, it must be noticed that even the response of employment and wage differentials is exactly the one we would expect on the basis of our theoretical model, conditionally to the hypothesis of skilled migration: the wage differential increases, whereas the gap between skilled and unskilled employment shows a tendency to decrease, especially in the medium run. This framework is compatible with the wide-spread opinion by which skilled workers are characterised by a lower level of unionisation and skilled and unskilled labour are complementary (Bauer and Zimmermann, 1997; Levine, 1999). At a first time, the simple increase in the stock of available skilled workers should reduce their wages which are not much protected by Unions and therefore are characterised by a higher degree of flexibility; for this, skilled labour demand should grow and so should the unskilled one, due to complementarity, no matter what the trade unions do, either increase or decrease the wage of unskilled workers. While it does not seem reasonable that the trade unions could increase the wage of unskilled workers so much to create a drop in employment, it is moreover reasonable to assume a drop in their wages such as to further amplify their increase of employment. The strong increase in the level of unskilled employment shifts again the skilled labour demand upwards with a relevant recovery of their wage level. The final outcome of the adjustment process should be coherent with the empirical proof revealed by IRFs: $(\downarrow w^s - w^{us} \downarrow\downarrow) \Uparrow$ e $(\uparrow n^s - n^{us} \uparrow\uparrow) \Downarrow$.

Also IRFs related to the other shocks are easy to interpret economically. A demand shock (first row of graphs in the panel) occurred in the sectors that are more skill intensive triggers a growth of all relevant relative variables: wages, employment and participation; the wage premium inflation and the growth in the probability of finding a job do encourage a higher skilled migration. Labour market reactivity with respect to productivity shocks (second row of graphs) seems instead limited: employment results being penalised, although just slightly, in the long run, which discourages participation and disincentives migration; on the contrary the wage receives an expected positive impulse that reflects the higher level of productivity of workers. Finally, a relative skilled to unskilled home participation shock (third row) generates a negative impact on the flexible skilled wage and also on the relative one and induces a contraction of (relative) migration flows bu leaves unaffected the relative level of employment.

This picture may be enriched by the analysis of FEVDs. Along with real demand, migration appears to be the most important phenomenon explaining the European relative employment behaviour in the medium-long run; the productivity and participation effects are weaker and respectively increasing and

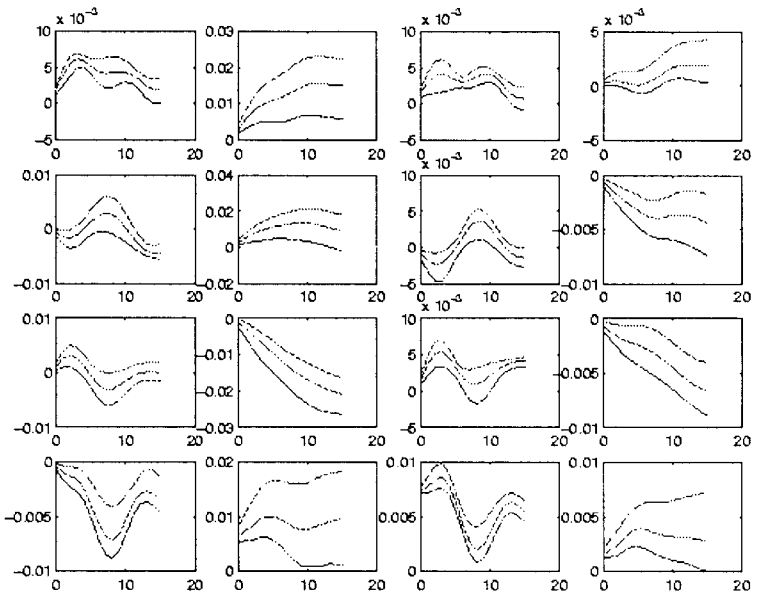

Figure 3:

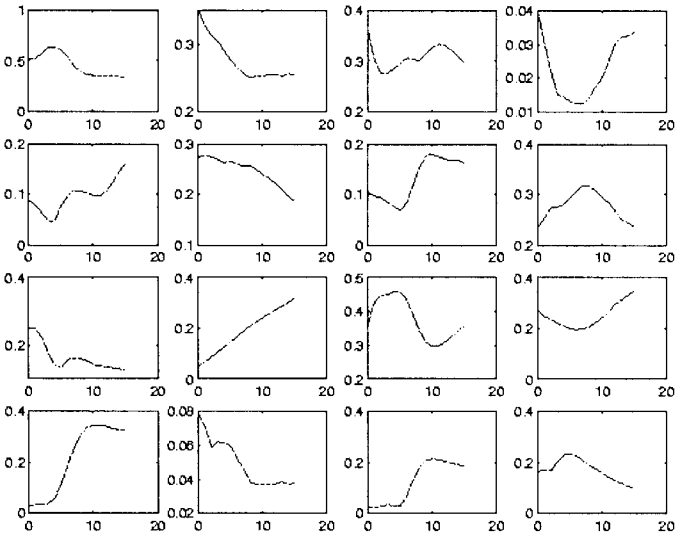

Figure 4:

decreasing with time. The evidence relative to wage further on strengthens the idea of a significant flexibility of labour market on the skilled side: it is in fact the interaction between labour demand and supply (with the latter effect prevailing in the long run) which determines the relative wage, which also shows also a high capability of reflecting the productivity level of workers.

The variance decomposition of migration suggests some remarks on the determinants of this phenomenon and shapes a quite puzzled picture:

- The explanatory capacity of real demand perturbations is limited, this leads to consider reasonable that in absolute terms the greater job opportunities are not the main element of attraction for skilled Eastern migrants that historically have a high propensity to easily find a job even in the regions of origin. However, demand shocks (see the IRFS plot) have positive effects on migration.
- The contribution given from productivity to explain the variance of the migration variable is significant, but "negative": a higher level of productivity seems to imply the substitution of labour with capital and therefore discourages the participation of native workers and migration flows.

6 Conclusions

In this paper we address one major and one minor issue among those characterising the macroeconomic literature on migration. Mainly we evaluate, both on the theoretical and on the empirical side, which impact is produced by the immigration flows coming from the enlargement countries over the EU-15 labour market. As a second point we try to draw, from the empirical analysis, clues on the features of East-West migration from the point of view of the skill levels of immigrants.

We adopt a insider/outsider type model inspired by that of Amisano and Serati (2003) but further on enlarged and corrected in order to (a) incorporate an equation that endogenously models the migration flows and (b) allow for modelling the trends of wage, participation and employment differentials between skilled and unskilled workers. After having estimated through Bayesian techniques the reduced VAR form of the theoretical model, we identify the structural shocks through sign restrictions imposed to the Impulse Response Functions (henceforth IRFs) and suggested from the theoretical model's impact multipliers. Within this framework we also try to obtain a set of information on the skill mix of the Eastern migrants leaving unconstrained only the impact multipliers of relative (skilled to unskilled) wage, employment and labour force with respect to a migration shock. This is equivalent to adopt an agnostic approach, letting emerge freely the signals coming from the data and combining them with theoretical suggestions in order to derive at least weak indications on the fact that the skill mix of migrants is either biased towards high or low qualified labour.

From our analysis it does emerge that migration from Eastern European countries towards the EU-15 is mainly constituted by skilled workers and generates effects of reduction of the employment gap; on the other side it enlarges the skilled to unskilled relative wage gap.

In the last 15 years the debate concerning the issue of migration policies and the management of migrants flow has been intense, deep and has often crossed academic and economic policy teams boundaries to capture political or ideological shades. We do not claim to add elements radically altering the ground of this debate: however, some brief remarks drawn from our empirical evidence can give a contribution, although marginal. Incentive strategies of skilled migration flows seem as a precious tool to increase the overall efficiency of the European labour market. They stimulate employment both skilled and unskilled and produce effects of overall stabilisation of wages, weakening the role of the Unions and softening the bias due to an excessive wage rigidity, especially in the unskilled segment of the market. Wage inequalities, on the contrary, seem to widen; such process is unpleasant from the social point of view, but in economic terms it indicates a more efficient operation of the market, which is able to reward relatively more the more productive workers. The implementation of such incentive strategies seems anyway to lead to the non exclusive use of economic instruments: in fact greater job opportunities and a significant wage skill premium are to be included in the factors of attraction but generate anyhow a limited

impact; other factors such as social or environmental, as well as economic in the weak sense (labour protection, welfare conditions, social status, career perspectives) most likely play a fundamental role. It is therefore desirable for incentive policies and control of migrant flows to be planned organically and adopting an eclectic approach which jointly takes into account of all these factors.

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8 Appendix

8.1 Equilibrium solution of the model.

$X^* = (A_0 + A_1)^{-1}\Theta\Xi = Q\Xi$

$$(A_0+A_1)=\begin{bmatrix}1 & \phi & 0 & 0\\ 0 & 1 & 0 & -\frac{\rho}{\phi}\\ 0 & 0 & 1 & -\gamma\\ -\kappa & 0 & \kappa & 1\end{bmatrix}+\begin{bmatrix}0 & 0 & 0 & 0\\ \frac{1-\lambda}{\phi} & 0 & \frac{\lambda}{\phi} & 0\\ -b & 0 & b & 0\\ 0 & 0 & 0 & 0\end{bmatrix}=$$

$$=\begin{bmatrix}1 & \phi & 0 & 0\\ \frac{1}{\phi}(-\lambda+1) & 1 & \frac{\lambda}{\phi} & -\frac{\rho}{\phi}\\ -b & 0 & b+1 & -\gamma\\ -\kappa & 0 & \kappa & 1\end{bmatrix},$$

$$(A_0+A_1)^{-1}=\begin{bmatrix}\frac{(b+\kappa\gamma+1)}{\lambda+\rho\kappa} & \frac{(-\phi-b\phi-\kappa\gamma\phi)}{\lambda+\rho\kappa} & 1 & \frac{(-\rho-b\rho+\lambda\gamma)}{\lambda+\rho\kappa}\\ \frac{(-b+\lambda+\rho\kappa-\kappa\gamma-1)}{\lambda\phi+\rho\kappa\phi} & \frac{(b+\kappa\gamma+1)}{\lambda+\rho\kappa} & -\frac{1}{\phi} & \frac{(\rho+b\rho-\lambda\gamma)}{\lambda\phi+\rho\kappa\phi}\\ \frac{b+\kappa\gamma}{\lambda+\rho\kappa} & \frac{(-b\phi-\kappa\gamma\phi)}{\lambda+\rho\kappa} & 1 & \frac{(-b\rho+\lambda\gamma)}{\lambda+\rho\kappa}\\ \frac{\kappa}{\lambda+\rho\kappa} & -\frac{\kappa\phi}{\lambda+\rho\kappa} & 0 & \frac{\lambda}{\lambda+\rho\kappa}\end{bmatrix}$$

$$Q=\begin{bmatrix}\frac{(b+\kappa\gamma+1)}{\lambda+\rho\kappa} & \frac{(-\phi-b\phi-\kappa\gamma\phi)}{\lambda+\rho\kappa} & 1 & \frac{(-\rho-b\rho+\lambda\gamma)}{\lambda+\rho\kappa}\\ \frac{(-b+\lambda+\rho\kappa-\kappa\gamma-1)}{\lambda\phi+\rho\kappa\phi} & \frac{(b+\kappa\gamma+1)}{\lambda+\rho\kappa} & -\frac{1}{\phi} & \frac{(\rho+b\rho-\lambda\gamma)}{\lambda\phi+\rho\kappa\phi}\\ \frac{b+\kappa\gamma}{\lambda+\rho\kappa} & \frac{(-b\phi-\kappa\gamma\phi)}{\lambda+\rho\kappa} & 1 & \frac{(-b\rho+\lambda\gamma)}{\lambda+\rho\kappa}\\ \frac{\kappa}{\lambda+\rho\kappa} & -\kappa\frac{\phi}{\lambda+\rho\kappa} & 0 & \frac{\lambda}{\lambda+\rho\kappa}\end{bmatrix}\times$$

$$\times\begin{bmatrix}\phi & \phi+a-1 & 0 & 0\\ 0 & 1 & 0 & 0\\ 0 & 0 & 1 & 0\\ 0 & 0 & 0 & 1\end{bmatrix}$$

$$\mathrm{Q(c.1,2)}=\begin{bmatrix}\frac{\phi(b+\kappa\gamma+1)}{\lambda+\rho\kappa} & \frac{(b+\kappa\gamma+1)(a-1)}{\lambda+\rho\kappa}\\ \frac{\phi(-b+\lambda+\rho\kappa-\kappa\gamma-1)}{\lambda\phi+\rho\kappa\phi} & -\frac{(a-b+\lambda+ab-a\lambda+\rho\kappa-\kappa\gamma-\lambda\phi-a\rho\kappa+a\kappa\gamma-\rho\kappa\phi-1)}{\phi(\lambda+\rho\kappa)}\\ \phi\frac{b+\kappa\gamma}{\lambda+\rho\kappa} & \frac{(b+\kappa\gamma)(a-1)}{\lambda+\rho\kappa}\\ \kappa\frac{\phi}{\lambda+\rho\kappa} & \frac{(a-1)\kappa}{\lambda+\rho\kappa}\end{bmatrix}$$

$$\mathrm{Q(c.3,4)}=\begin{bmatrix}1 & \frac{(-\rho-b\rho+\lambda\gamma)}{\lambda+\rho\kappa}\\ -\frac{1}{\phi} & \frac{(\rho+b\rho-\lambda\gamma)}{\lambda\phi+\rho\kappa\phi}\\ 1 & \frac{(-b\rho+\lambda\gamma)}{\lambda+\rho\kappa}\\ 0 & \frac{\lambda}{\lambda+\rho\kappa}\end{bmatrix}$$

We may observe that:

- $\frac{\partial(n_t^s-n_t^{us})^*}{\partial\tilde{d}_t}=\frac{\phi(b+\kappa\gamma+1)}{\lambda+\rho\kappa}>0;\ \frac{\partial(w_t^s-w_t^{us})^*}{\partial\tilde{d}_t}=\frac{\phi(-b+\lambda+\rho\kappa-\kappa\gamma-1)}{\lambda\phi+\rho\kappa\phi}\lesseqgtr 0;$

  $\frac{\partial(l_t^s-l_t^{us})^*}{\partial\tilde{d}_t}=\phi\frac{b+\kappa\gamma}{\lambda+\rho\kappa}>0;\ \frac{\partial(mg_t^s-mg_t^{us})^*}{\partial\tilde{d}_t}=\kappa\frac{\phi}{\lambda+\rho\kappa}>0$

- $\frac{\partial(n_t^s-n_t^{us})^*}{\partial\tilde{\theta}_t}=\frac{(b+\kappa\gamma+1)(a-1)}{\lambda+\rho\kappa}<0;\ \frac{\partial(w_t^s-w_t^{us})^*}{\partial\tilde{\theta}_t}=-\frac{(a-b+\lambda+ab-a\lambda+\rho\kappa-\kappa\gamma-\lambda\phi-a\rho\kappa+a\kappa\gamma-\rho\kappa\phi-1)}{\phi(\lambda+\rho\kappa)}\lesseqgtr 0;$

  $\frac{\partial(l_t^s-l_t^{us})^*}{\partial\tilde{\theta}_t}=\frac{(b+\kappa\gamma)(a-1)}{\lambda+\rho\kappa}<0;$

  $\frac{\partial(mg_t^s-mg_t^{us})^*}{\partial\tilde{\theta}_t}=\frac{(a-1)\kappa}{\lambda+\rho\kappa}<0$

- $\frac{\partial(n_t^s-n_t^{us})^*}{\partial\tilde{z}_t}=1>0;\ \frac{\partial(w_t^s-w_t^{us})^*}{\partial\tilde{z}_t}=-\frac{1}{\phi}<0;$

$\frac{\partial(l_t^s - l_t^{us})^*}{\partial \tilde{z}_t} = 1 > 0; \frac{\partial(mg_t^s - mg_t^{us})^*}{\partial \tilde{z}_t} = 0$

- $\frac{\partial(n_t^s - n_t^{us})^*}{\partial \xi_t} = \frac{(-\rho - b\rho + \lambda\gamma)}{\lambda + \rho\kappa} \lesseqgtr 0; \frac{\partial(w_t^s - w_t^{us})^*}{\partial \xi_t} = \frac{(\rho + b\rho - \lambda\gamma)}{\lambda\phi + \rho\kappa\phi} \lesseqgtr 0;$

$\frac{\partial(l_t^s - l_t^{us})^*}{\partial \xi_t} = \frac{(-b\rho + \lambda\gamma)}{\lambda + \rho\kappa} \lesseqgtr 0; \frac{\partial(mg_t^s - mg_t^{us})^*}{\partial \xi_t} = \frac{\lambda}{\lambda + \rho\kappa} > 0$